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ABSTRACT

A first-grade teacher implemented a practicum intervention designed to increase the availability and use of manipulative materials for mathematics activities in kindergarten, first-, and second-grade classes. Primary goals were to: (1) provide teachers with the understanding and competence needed to incorporate the use of manipulative materials into their mathematics instruction; (2) increase student and teacher use of manipulative materials; and (3) increase availability of reference publications related to mathematics instruction in primary grades. In the effort to reach these goals, a teacher questionnaire was administered, the availability and use of selected materials was assessed, an inventory of publications was made, workshops for teachers were presented, fund-raising activities were developed, and the effectiveness of the intervention was evaluated. Practicum evaluation data indicated that the intervention had positive effects. There were significant gains in availability and use of the selected materials. Teachers indicated that the related staff development activities helped them gain understanding and competence in integrating manipulatives into their regular course of mathematics instruction. Related materials in six appendices included: (1) teacher questionnaire; (2) survey of availability and usage of selected materials; (3) inventory of mathematics resource/reference publications; (4) teacher observation checklist; (5) weekly log; and (6) staff development activities rating scale. (RH)

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Increasing the Availability and Usage of Mathematics Manipulatives in K-2 Through Effective Related Staff Development Activities

by

Karol L. Yeatts

Cluster 25

A Practicum I Report Presented to the Ed.D Program in Early and Middle Childhood in Partial Fulfillment of the Requirements for the Degree of Doctor of Education

NOVA UNIVERSITY

1989

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PRACTICUM APPROVAL SHEET

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This practicum report was submitted by Karol L. Yeatts under the direction of the adviser listed below. It was submitted to Ed.D. Program in Early and Middle Childhood and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova University.

Approved:

Date of Final Approval of Report

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ABSTRACT

Increasing the Availability and Usage of Mathematics Manipulatives in K-2 Through Effective Related Staff Development Activities. Yeatts, Karol L., 1989: Practicum Report, Nova University, Ed.D. Program in Early and Middle Childhood.
Descriptors: Mathematics Instruction / Manipulatives / Primary Education / Staff Development

This practicum addressed the problem of a lack of availability and usage of mathematics manipulatives in K-2 classrrooms. This lack of materials resulted in a lack of understanding of basic mathematical concepts and a disinterest in mathematics. The literature review disclosed evidence of the importance for using math manipulatives and presented suggestions for increasing teachers' and students' usage of these materials.

The primary goals were to provide teachers with an understanding and competence for incorporating the use of manipulatives in their mathematics instructions; to increase the availability of selected materials; to increase students' and teachers' usage of manipulative materials; and to increase the availability of resource/reference publications relating to mathematics instruction in primary grades. In addressing these goals, the writer administered a teacher questionnaire, a survey of availability and usage of selected materials, and an inventory of resource/reference publications; presented a series of mini workshops for teachers; served as a facilitator for teachers; developed fund raising activities; and developed and administered an evaluation component.

The results of the practicum were positive. Analysis of the data revealed signifcant gains in both availability and usage of the selected materials. Teachers indicated that the related staff development activities were very successful as they helped them gain an understanding and competence in integrating the use of manipulatives into their mathematics instruction.

CHAPTER I

INTRODUCTION

Description of Community

The setting for this practicum is a school located at the southern most extreme of a peninsula state. The school is situated within a rural residential area and is surrounded by plush agricultural farming land.

The community surrounding the school has a population of approximately 23,000 residents and is rapidly increasing. The area is favored by many for retirement because of its rural atmosphere, but easy access to the advantages of a large metropolitan area.

The socioeconomic makeup of the community is generally middle class. However, due to the large farming industry there are areas of extreme poverty. Areas of extreme wealth exist as well within the community.

Agriculture is the predominant economic influence in this area as it is the number one source of income and employment for many of the area residents. Almost before the sun rises the fields are teeming with activity as the area supports some of the most agriculturally productive land in the nation.

In addition to the agriculture industry, one of the nation's largest military installations is located within the community. There are approximately 12,000 military people located within the base area which is the home of the Air Force, Navy, and Marine Corps U.S. Defense Team.

Other industries play an increasingly important role. Tourism ranks third as a major industry in the community. Additionally, one of the world's largest power plants is located

within the area. The power plant provides a variety of employment opportunities.

Writer's Work Setting

The school's permanent physical facility is presently twenty-seven years old and consists of two permanent building wings containing fourteen classrooms. Adjoining buildings include a cafetorium, an office, and a media center. In addition to the permanent structure there are ten wooden portable classrooms and three relocatable buildings. The percent of utilization of the permanent facility is 132% which indicates an overcrowded situation.

The school population consists of approximately 520 students which includes: 43.8% white non-hispanic, 26.5% black non-hispanic, and 29.7% hispanic. The school houses students in grades K-5 with approximately 75 kindergarteners, 90 first graders, 100 second graders, 90 third graders, 80 fourth graders, and 80 fifth graders.

The school mobility indicator is 38% which is a result of the farm labor workers moving in and out of the area according to the growing season and military personnel being assigned to the military base or relocated to another facility.

At present there are seventeen basic education classes, seven Chapter 1 classes, two learning disablities classes, one intensive speech class, a computer lab, and a bilingual program with ESOL classes, Spanish S, and Spanish SL. Of the total hispanic population, 11.4% have limited English proficiency and are served by the ESOL program. Additionally, 4% of the total school population participates in the exceptional education program. The school also offers classes in art, music, physical education, and computers. Other services offered by the school include bus transportation with approximately 100 students being bused to and

from the school each day. Due to the economic conditions of the community, the school provides a breakfast and lunch program with 58.7% of the enrolled students participating in this program.

The administration consists of a principal and an assistant principal. There is one guidance counselor whose support services assist students in their personal, social, emotional, intellectual, and career development. In addition to the administration, the faculty consists of thirty-four instructional personnel. Of this number 60% are white nonhispanic, 26% are black nonhispanic, and 14% are hispanic. There are ten staff members with master's degrees (32%) and one staff member with a specialist's degree (3%). The average number of years of teaching in the state is 9 years.

The school's philosophy emphasizes the education of the total child. The philosophy stresses the development of each students' potential for learning and fosters the development of positive relationships. The school has adopted the characters from the Wizard of Oz to emphasize these qualities. The scarecrow represents the academics, the tinman stresses the positive human relations, and the lion represents courage, to venture forward, yet to have the strength and courage to stand up and say "no" to dangerous situations. The school slogan states, "Be smart, have a heart and do your part".

The practicum subject dealt with mathematics instruction. The participants for this practicum included kindergarten, first grade, and second grade teachers, and students in grades K-2. The 1987-88 Stanford Achievement Test (SAT) median percentile results in mathematics for these grades are listed on Table 1.

Table 1

1987-88 SAT Median Percentiles

Subject	Grade K	Grade 1	Grade 2
Mathematics	44	--	--
Math Computation	--	49	73
Concepts of Numbers	--	56	75
Math Application	--	--	63
Total Math	--	56	74

Writer's Role and Responsibilities

The writer is a native of the area and her first twelve years of education occurred within the local county school system in which she is currently employed. Working her way through college, the writer began her employment with the county school system as a clerk in the purchasing department.

The writer has a bachelor's degree in elementary education and a master's degree in early childhood education. After completing her bachelor's degree the writer taught kindergarden for two years at a private school. After receiving her master's degree the writer designed, directed and taught in a church sponsored preschool for two years.

The writer, as previously mentioned, is currently employed as a teacher by one of the nation's largest public school systems. For the past seven years she has taught first grade at the same school site in which the practicum was implemented. She has served as grade level chairperson, as the school's TEC (Teacher

Education Center) representative, and as a member of the school's discipline committee.

The writer has been active on the county level as well. She served as a facilitator and writer for the county school system's career education department; assisted in writing a second grade career awareness learning activity package; and was responsible for creating and writing the kindergarten career awareness program. The writer also served on the writing team which designed the pre and posttests for the validation study of the county school system's Career Awareness and Basic Skills program.

CHAPTER II

STUDY OF THE PROBLEM

Problem Description

Today there is an emphasis on standardized curriculcum, testing, and accountability. Kindergarten, first grade, and second grade teachers are responding to the pressures to increase test scores and of having to reach specific levels of student competence by demanding that students complete page after page in workbooks before the students have an opportunity to develop prerequisite skills for these pencil and paper activities.

It appears that many teachers feel that the only way to demonstrate students' increased competencies and mastery of skills is through paper and pencil tasks. These papers provide the concrete evidence of progress which satisfies the administration and the parents. However, this type of evidence ignores the dictates of child developmentalists. Thus the discovery through manipulation of the environment has been greatly curtailed.

When children enter school at the age of five, most are still in the preoperational stage of development as described by Piaget. Children during this phase of development deal best with concepts through activities involving the senses. Activities involving concrete materials are needed which allow children the opportunity to actively manipulate objects in order to begin to construct knowledge about their environment. Children need to begin their learning with concrete materials for exploration purposes. This should be followed by a period of instruction prior to the assignment of paper and pencil tasks. This procedure would produce greater understanding of and success in the completion of such tasks.

Mathematics manipulatives are familiar teaching tools which assist in the development of basic mathematical concepts. These

manipulatives are objects that appeal to several of the senses. The senses are stimulated as the children touch the manipulative materials, move them about, rearrange them, and see them in various patterns and groupings. The general consensus is that experiences with mathematics manipulatives help provide a strong basis for conceptual understandings. Therefore, the main purpose of mathematics manipulatives is to assist students in bridging the gap from their own concrete environment to the more abstract levels of mathematics.

The county school system's adopted textbooks and curriculum for mathematics instruction contain minimal suggestions for using manipulatives to introduce mathematical concepts. Suggested materials listed in the teachers' editions are not readily available to the teachers. There are a few disposable manipulatives provided in the student's individual workbooks. However, these materials fail to meet many of the physical criteria for the selection of manipulatives. These materials are easily torn and often lost by the students.

In practice, the amount of time spent using manipulatives by teachers for mathematics instruction is extremely small. The use of manipulatives by students for developing mathematical concepts is equally small. It was noted by this writer that most K-2 teachers at the writer's school site did not use manipulatives during mathematics instruction, therefore, students did not use manipulatives. This observation was a result of the writer's informal discussions with other K-2 grade teachers.

It was this writer's observation that manipulatives were not widely used for mathematics instruction by K-2 teachers in this school despite the abundance of research indicating the value and importance of using manipulatives for teaching mathematical concepts. The teachers at the writer's work setting did not have an adequate supply of manipulatives for their classroom nor did

they have a working understanding of how to integrate the use of manipulatives into their instruction of mathematics.

In conclusion, the problem to be addressed by this practicum was that teachers and students were not using developmentally appropriate manipulative materials for instruction and acquisition of mathematical concepts.

Problem Documentation

In order to provide documentation of the problem stated in the previous section, the writer designed a Teacher Questionnaire (see Appendix A), a Survey of Availability and Usage of Selected Materials (see Appendix B), and Frequency Usage Score, and an Inventory of Mathematic Resource/Reference Publications (see Appendix C). The Teacher Questionnaire and Survey of Availability and Usage of Selected Materials were given to a total of twelve K-2 grade teachers. The Inventory of Mathematics Resource/ Reference Publications was given only to the school's media specialist who is responsible for maintaining the curriculum library at the school site.

The teacher questionnaire was designed to note the teachers' awareness of and understanding for the use of manipulatives. Additionally, the questionnaire was designed to assess whether teachers would like to have more manipulatives for use in their classrooms and whether they were interested in attending workshops or in-service activities pertaining to the use of mathematics manipulatives.

The questionnaire contained specific questions concerning the teachers' beliefs and understanding of the value of manipulatives for teaching mathematical concepts. Teachers were asked to rank each question on a scale from 1 to 5. A score of 5 indicated that the teacher strongly agreed with the question item. A score of 4 was given if the teacher agreed with the item. A response of 3

indicated that the teacher somewhat agreed. A score of 2 indicated that the teacher disagreed with the item and a score of 1 indicated that the teacher strongly disagreed with the item. A total of twelve K-2 teachers participated in completing the questionnaire. The results of their responses are presented on Table 2.

The results of item #7 indicated that only three teachers strongly agreed that they felt comfortable using mathematics manipulatives. The remaining teachers agreed or somewhat agreed with this item. These results provided evidence that teachers at the writer's work setting were not using manipulatives because they did not feel comfortable integrating the use of manipulatives into their instruction of mathematical concepts. The results of item #8 indicated that seven teachers strongly agreed that they understood the value of using math manipulatives while the others somewhat agreed. These results provided evidence that teachers at the writer's work setting did have an understanding of the value of using manipulatives but were not putting that understanding into practice. The results of item #9 provided evidence that at least half of the teachers at the writer's work setting were not readily using additional resource or reference materials for suggestions to use in their classroom.

Item #16 results provided evidence that teachers at the writer's work setting generally believed that mathematics manipulatives were too expensive to purchase. The results of item #25 provided evidence that teachers at the writer's work setting did need and want additional mathematics manipulatives. Item #27 results provided evidence that the majority of K-2 grade teachers at the writer's work setting would like to attend workshops and/or in-service activities pertaining to the use of manipulatives for teaching mathematical concepts.

Item #30, "How many days per week do students use math manipulatives", indicated that there were no students using

Table 2

Teacher Questionnaire Results

Questionnaire Items	No. Responses Ranking 5	4	3	2	1
1. Math is one of my favorite subjects to teach.	4	2	4	0	2
2. I am satisfied with the present math text.	2	2	6	2	0
3. The math textbook is my main teaching aid.	3	3	5	1	0
4. Adequate math manipulative materials are supplied in each student's workbook.	2	1	4	4	1
5. The teacher's edition gives adequate suggestions for using manipulatives for teaching a lesson.	2	2	7	1	0
6. My present knowledge of the use of math manipulatives is adequate.	2	6	2	1	1
7. I feel comfortable about using manipulatives to teach math concepts.	3	5	3	0	1
8. I understand the value of using manipulatives for teaching math concepts.	7	4	1	0	0
9. I use resource/reference publications for ideas and ways for using manipulatives to teach math.	4	2	5	1	0
10. I use math manipulatives when teaching new concepts.	2	3	7	0	0
11. I use math manipulatives only when reinforcing concepts.	1	0	7	3	1
12. My students use manipulatives when completing their assignments.	1	0	7	1	3
13. My students do not need to use manipulatives when completing their assignments.	1	0	5	2	4
14. Manipulatives act only as a crutch and can do more harm than good.	0	1	2	2	7
15. There is not enough time to use manipulatives for teaching math concepts.	2	2	4	2	2
16. Math manipulatives are usually too expensive.	2	5	3	1	1
17. I have an adequate supply of math manipulatives.	1	2	1	3	5
18. I do not need additional math manipulatives.	1	1	0	5	5
19. I believe the use of math manipulatives can assist in building a strong basic foundation.	7	1	4	0	0
20. Fast learners do not need to use math manipulatives.	1	0	4	3	4
21. Average learners benefit from the use of math manipulatives.	2	8	2	0	0
22. Slow learners benefit the most from the use of math manipulatives.	6	5	1	0	0
23. Math manipulatives are not needed above kindergarten and first grades.	0	1	2	4	5
24. The use of math manipulatives is troublesome as students only play with the materials.	1	0	3	5	3
25. I would like to have more math manipulatives for use in my classroom.	5	3	2	2	0
26. I have attended workshops on using math manipulatives.	1	4	0	4	3
27. I would be interested in attending future workshops concerning the use of math manipulatives in the classroom.	5	3	3	0	1

28. How much time do you devote to teaching math each week?

__1__ 0-2 hours __0__ 4-6 hours

__2__ 2-4 hours __1__ 6 or more hours

29. How many days per week do you use math manipulatives when teaching math?

__2__ 0 days __2__ 2 days __2__ 4 days

__4__ 1 day __2__ 3 days __0__ 5 days

30. How many days per week do students use math manipulatives?

__2__ 0 days __1__ 2 days __3__ 4 days

__4__ 1 day __2__ 3 days __0__ 5 days

manipulatives 5 days per week. Three out of the twelve teachers indicated that their studens were used manipulatives 4 days per week. Two teachers indicated that their students used manipulatives 3 days per week. One teacher indicated that the students used manipulatives 2 days per week. Four teachers indicated that their students used manipulatives 1 day per week and 2 teachers indicated that their students did not use manipulatives. The results of this item provided evidence that students at the writer's work setting were not frequently using manipulatives during mathematics instruction.

The Survey of Availability and Usage of Selected Materials was designed to note the current availability of selected manipulatives that K-2 grade teachers at the writer's work setting possessed and to determine the frequency with which the materials were used. A total of 36 mathematics manipulatives were listed on the survey. The teachers were asked to indicate whether they had the item. If the teacher did possess an item she was then asked to check the appropriate column to indicate the frequency with which the item was used. The responses for usage included: "Very often" - more than 10 times a year, "Often" - 5 to 6 times a year, "At times" - 3 to 4 times a year, "Rarely" - 1 to 2 times a year, and "Never" - 0 times a year.

The preimplementation results of the survey are shown on Table 3. The results of the availability indicated that of the 36 selected manipulatives 11 were reported available to at least half of the teachers. These items included: beads, calendars, clocks, counters, flash cards, metric rulers, money kits, number lines, popsicle sticks, puzzles, and yardsticks. Of the 36 selected manipulatives 25 were not available to over half of the teachers. These items included: abacus, attribute blocks, bottle caps, calculators, chip trading kits, containers, counting frames, cuisenaire rods, dominoes, fraction sets, geoboards, geometric forms, measuring cups, measuring spoons, number rods, parquetry

Table 3

Preimplementation Survey of Availability and Usage of Selected Materials Results

	Availability	Usage				
Teaching aid	Have	Very often	Often	At times	Rarely	Never
Abacus	5	0	1	4	0	0
Attribute blocks	2	0	0	2	0	0
Beads	7	0	2	5	0	0
Bottle tops	1	0	1	0	0	0
Calculators	3	0	2	1	0	0
Calendar	12	8	4	0	0	0
Chip trading	2	0	0	1	1	0
Clocks	11	3	3	4	1	0
Containers (qt,pt)	3	0	0	3	0	0
Counters	9	4	2	1	2	0
Counting frame	1	0	0	1	0	0
Cuisenaire rods	3	0	1	2	0	0
Dominoes	5	0	0	3	2	0
Flash cards	9	6	2	0	1	0
Fraction sets	2	1	0	1	0	0
Geoboards	1	1	0	0	0	0
Geometric forms	2	0	0	2	0	0
Measuring cups	3	1	0	1	1	0
Measuring spoons	1	0	1	0	0	0
Money kits	6	1	0	3	2	0
Number lines	6	0	0	1	4	1
Number rods	1	0	0	1	0	0
Parquetry kits	1	1	0	0	0	0
Peg boards & pegs	2	0	0	1	1	0
Place value chart	2	0	1	1	1	0
Popsicle sticks	7	1	3	2	1	0
Puzzles	7	3	3	1	0	0
Rulers, metric	6	1	1	2	2	0
Scales	1	0	0	1	0	0
Sorting kits	2	0	0	0	0	2
Tangrams	1	0	0	1	0	0
Thermometers	2	1	0	0	0	1
Timers	1	0	0	0	1	0
Telephone	1	1	0	0	0	0
Unifix cubes	0	0	0	0	0	0
Yardstick	6	2	0	1	4	1

kits, peg boards and pegs, place value charts, scales, sorting kits, tangrams, telephones, thermometers, timers, and unifix cubes.

To determine the frequency with which these manipulative were used by the teachers the writer computed a frequency usage score. A frequency usage score was calculated by assigning a value to each response. The assigned response values included: "Very often" - 4 points, "Often" - 3 points, "At times" - 2 points, "Rarely" - 1 point, and "Never" - 0 points. If for example, the abacus had four responses "At times" and one response "Often", the resulting frequency usage score would be 11. The equation would be 4 x 2 + 3 = 11 ("At times" = 2 points x 4 responses and "Often" = 3 points x 1 response).

The preimplementation results of the frequency usage scores are noted on Table 4. The highest obtainable frequency usage score was 48. However, none of the selected manipulatives resulted in such a score. The preimplementation results of the frequency usage scores indicated that calendars, flash cards, clocks, counters, and puzzles were the most frequently used manipulatives with scores of 44, 31, 30, 26, and 23 respectively. Unifix cubes, timers, counting frames, number rods, and tangrams were the least used manipulatives with scores of 0, 1, 2, 2, and 2 respectively.

The results of the availability and frequency usage surveys provided evidence that teachers at the writer's work setting did not have an adequate supply of mathematics materials and did not frequently use manipulatives while teaching mathematical concepts to their students.

The Inventory of Mathematics Resource/Reference Publications was designed to note the current availability of supplemental materials for teachers to use at the school site. The results of the inventory clearly provided evidence that supplemental

Table 4

Preimplementation Frequency Usage Scores

Selected Materials	Scores
Abacus	11
Attribute blocks	4
Beads	16
Bottle tops	3
Calculators	8
Calendar	44
Chip trading	3
Clocks	30
Containers (qt,pt)	6
Counters	26
Counting frame	2
Cuisenaire rods	7
Dominoes	8
Flash cards	31
Fraction sets	0
Geoboards	4
Geometric forms	4
Measuring cups	7
Measuring spoons	3
Money kits	12
Number lines	18
Number rods	2
Parquetry kits	4
Peg boards & pegs	3
Place value chart	5
Popsicle sticks	18
Puzzles	23
Rulers, metric	13
Scales	2
Sorting kits	8
Tangrams	2
Thermometers	4
Timers	1
Telephone	4
Unifix cubes	0
Yardstick	14

materials were not available for teachers at the writer's work setting. Of the 20 publications listed on the inventory the school site curriculum library only had one of the publications, Instructor.

In conclusion, the preimplementation results of the Teacher Questionnaire, the Survey of Availability and Usage of Selected Materials, the Frequency Usage Scores, and The Inventory of Mathematics Resource/Reference Publications provided evidence of the writer's belief that:

1. Mathematics manipulatives were not readily available to K-2 teachers.
2. Teachers and students did not frequently use manipulatives during mathematics instruction.
3. Teachers were interested in attending workshops or in-service activities to improve their skills for integrating the use of manipulatives into their instruction of mathematical concepts.
4. Teachers at the writer's work setting did not have supplemental materials available to assist in improving or enhancing their mathematics instruction.

Causative Analysis

The problem concerning the lack of availability and usage of mathematics manipulatives in K-2 classrooms had several causes. The writer believed that one cause was that teachers were not adequately prepared or skilled in integrating the use of manipulatives for teaching math concepts. Therefore, teachers did not use manipulatives for teaching mathematical concepts to their students.

Colleges and universities normally require elementary education majors to take only one or two methods classes in mathematics. This writer does not believe that one methodology course is sufficient to train teachers to use various approaches for teaching mathematics. Preschool, primary, and intermediate grade children are in different phases of development and require different instructional approaches. Mastering a variety of instructional approaches within one course time block is not an easy task for anyone.

A second cause of the problem was that teachers did not have resources available to assist them in using mathematics manipulatives or to update their skills and understanding for teaching mathematics. Resource guides, educational magazines, and journals which present many ideas for enhancing and improving classroom instruction were not available to teachers at the writer's school site. Additionally, methodology workshops or in-service activities to enable teachers to update or improve their classroom instruction were not readily available to teachers at the writer's school site.

A third cause of this problem was that teachers did not have an adequate supply of manipulatives to use for teaching mathematical concepts. The writer believed this was based on financial constraints placed on the Department of Education. Educational funds were used to purchase textbooks, workbooks, skill packages, computers and computer software. If any monies were left after purchasing workbooks, mathematics manipulatives may be considered. But, because commerical manipulatives were usually very expensive they were often overlooked or put aside. Without available manipulatives, instruction using manipulatives was obviously impossible.

A fourth cause of this problem pertained to the teachers' concerns about management and control. Teachers often claimed that there was not enough time available to use manipulatives and

that students usually ended up playing with the manipulatives. In addition, teachers claimed that manipulatives were difficult to manage with large numbers of students. This problem stemmed from the previous problems in that teachers were not adequately prepared to use various instructional approaches and manipulative materials. Using manipulatives may seem like game playing. However, allowing students to have fun while thinking and discovering is a rewarding part of teaching.

A fifth cause of this problem was that students were not using mathematics manipulatives to develop their understanding of mathematical concepts. Manipulatives are multipurposeful as they motivate students, stimulate students to think mathematically, and informally introduce students to higher level mathematical concepts. Research indicated that through the use of a manipulative approach to teaching mathematics, achievement test scores are shown to increase.

The Related Literature

A review of related literature acknowledged the value and importance of using manipulatives for developing an understanding of mathematical concepts. During the past twenty years researchers have investigated the academic gains made by students using manipulatives in their acquisition of mathematical concepts. Cognitive developmentalists have described and documented the ways children develop knowledge through the manipulation of concrete objects. Classroom teachers have provided additional evidence indicating the value and importance of using manipulatives in assisting the development of mathematical concepts.

Kennedy (1986) reviewed the learning theorist, the research, and the classroom application supporting the use of manipulatives for developing mathematics concepts. The author summarized Brownell, Piaget, Skemp, and Dienes, all of whom advocated the use of manipulative materials and suggested that children who are

exposed to the use of manipulatives better understand the meaning, the idea, and the application of the concept. The research summarized by the author indicated that the use of manipulatives at all grade levels resulted in increased academic gains. Support from the classrooms demonstrated that manipulatives enhance learning, generate interest, motivate, and stimulate the learning of mathematics.

Williams and Kamii (1986) described what children learn and how they learn when they manipulate objects. Reference was made to Piaget's theory of cognitive development which explains how information and knowledge is acquired as children handle objects. The authors clarified the term "manipulation" as it refers to the external act which can be mindless. The Piagetian term "action" refers to mental action which is often accompanied by physical action. Williams and Kamii explained that it is not the manipulation of objects in itself that is important for children, it is the mental action that is encouraged when children act on the objects themselves.

Charlesworth (1984) presented a paper at the Annual Conference of the National Association for the Education of Young Children. The paper included developmental characteristics of young children. The author explained that young children need to explore and discover concepts and use concrete materials in their initial mathematics instruction before moving on to paper and pencil tasks. The author included documented evidence that young children learn best when allowed to actively participate in their own acquisition of knowledge. A six step guide which provided a sequence for moving from concrete materials to paper and pencil tasks when teaching mathematics to kindergarten students, and a specific example which illustrated this process was included in the paper.

Creswell, Gifford and Huffman (1988) discussed the current implications regarding left/right brain functions. Research

indicates that during the sensorimotor stage, the right hemisphere is dominant. During the preoperational stage, the right hemisphere remains active as the left hemisphere is developing. During the concrete operational stage, both hemispheres are active. With these findings the authors stressed that elementary teachers should spend much of their instructional time in the use of concrete materials and that manipulatives should be used with any grade level to promote effective learning. In closing, the authors presented mathematical activities for different grade levels which are designed to activate the right and left hemispheres of the brain.

VanDevender and Rice (1984) explored the effects of various mathematics teaching approaches on second grade students' achievement and attitudes. Students were randomly assigned to one of the four instructional groups which included: a formalized, structured- textbook approach; a variety of hands-on manipulative activities without the use of a textbook; a textbook-manipulative approach; or no instruction on the mathematics unit. The results revealed that students in the manipulative only group had the greatest gains in achievement and attitudes. The textbook-only group had the lowest gains in both areas. The textbook- manipulative group also revealed gains, but not as great as those experienced by the manipulative-only approach.

Smith, Szabo and Trueblood (1980) randomly assigned sixty-six first and second grade students to one of three different instructional modes for teaching linear measurement skills. The three modes included: a manipulative mode; a graphic mode; and an abstract mode. In the manipulative mode the teacher demonstrated linear measurement using concrete materials, the students were also allowed to use the materials. In the graphic mode the teacher used pictures, filmstrips and charts to illusrate linear measurement skills. In the abstract mode the teacher provided verbal instructions and explanations of the skills. The results

indicated that students receiving instruction in the manipulative mode produced greater acquistion skills than students participating in the graphic mode. The conclusion supported the assertion made by curriculum developers that concrete, manipulative teaching methods seem to be more effective with young students than graphic or abstract methods.

Sowell (1987) described the purposes, materials, and roles of teachers and students in developmental and practice lessons of instruction. Developmental lessons help students understand mathematical concepts by allowing students to participate in concrete experiences using manipulative objects. Practice lessons may utilize manipulative materials, but these materials are usually replaced by symbols as students acquire proficiency with the mathematical concept. Sowell concluded that developmental lessons help students understand math concepts while practice lessons transform students' understanding into permanent knowledge.

Tobin and Fraser (1988) described the findings of the Exemplary Practice in Science and Mathematics Education Study conducted in Western Australia. The findings of the study indicated four important practices that led to effective teaching. Those practices included: effective managerial strategies; encouraged student participation in learning activities; the use of strategies designed to increase student understanding which included activities based on the use of manipulatives; and learning environments which were perceived as favorable by students.

The related literature indicated that manipulatives are effective tools for assisting and enhancing the development of mathematical concepts. However, there remains the question of whether manipulatives are actually being used by the classroom teachers during math instruction.

Kutz (1977) designed a survey to determine what manipulative materials were being used in North Dakota elementary school classrooms and by whom these materials were used. The results were gathered from 989, K-6 grade, teachers. The results indicated that 48% of the teachers rarely used manipulatives while 7% indicated extensive use. Materials most widely used were metric materials, counting chips, and bundles of sticks.

Wiebe (1981) developed a questionnaire to determine what kinds of mathematics manipulatives teachers have in their classrooms, how frequently manipulatives were used, the way manipulatives were used, and who used the manipulatives. The results indicated that mathematics materials were available in most of the classrooms, but most items did not receive frequent use. The results indicated that teachers significantly overestimated the amount of time in which they used manipulatives for teaching mathematics or in which their students used the materials. The findings also, indicated that mathematics manipulatives were used primarily for drill and practice rather than for developing mathematical concepts or for problem solving and inquiry.

Scott (1983) conducted a survey to gain information on the current use of manipulatives for teaching elementary mathematics in a large urban school district. In addition to obtaining information about manipulative usage, the survey was intended to provide information as to whether there was a need or desire for in-service activities pertaining to the use of mathematics materials. The results of Scott's survey indicated that few K-5th grade teachers used any manipulative materials more than five times a year. The results also indicated that of the twenty-five items listed only rulers and flash cards were used by 55% of the teachers. Ten items were used by at least 33% of the teachers and included: rulers, flashcards, cuisenaire rods, geoboards, popsicle sticks, tangrams, thermometers, counting chips, containers for

measuring, and abacuses. The survey further indicated that, although there was not a particularly high use of manipulatives, 81.2% of those responding requested more materials. Additionally, more than 50% of the teachers expressed an interest in attending in-service activities pertaining to the use of mathematical materials.

Perry and Grossnickle (1987) examined two major questions concerning the use of mathematics manipulatives in the primary grades. The first question examined current research which addressed the values of using math manipulatives. The studies cited by the authors supported and favored the use of manipulatives for teaching primary mathematics. To examine the second question a survey was conducted to determine the extent of availability and usage of math manipulatives. The results indicated that 79% of the teachers rated the use of math materials as essential and 21% rated their use as desirable. The results indicated a wide variation in the use of manipulatives with 92% of the teachers reporting that they used some type of manipulative, at some time, while teaching mathematics. The results of the use of manipulatives indicated that unifix cubes were the most frequently available manipulative with 92% of the teachers reporting their availability. However, only 75% of the teachers reported using unifix cubes. Seventy-one percent of the teachers reported the availability of cuisenaire rods with only 33% of the teachers reporting the use of these materials. Forty-five percent of the teachers reported the availability of base ten blocks and abacuses with only 37% reporting their use.

Scott (1987) conducted a survey to determine whether mathematics materials were in fact being used by elementary teachers in a large urban school district. The difference between the use of mathematics materials in an 1981 survey (Scott, 1983) and the present survey were remarkable. The results indicated that the investment in mathematics materials and related

in-service activities accounted for an increase in the use of manipulatvies for teaching mathematics. A chi square test yielded a significant difference at the .01 level. Rulers, however, remained the material that received the most use with 95.6% of the teachers using this manipulative. Geoboards, base ten blocks, thermometers, and geoblocks were used by 80% of the teachers. Math balances, compasses and protractors were used by 70% of the teachers.

Kloosterman and Harty (1987) surveyed elementary school principals in Indiana concerning their teaching staff's use of materials for teaching science and mathematics. The results showed that in grades K-2, 40% of the principals indicated that almost all their teachers had commercially-made manipulatives available to use and 42% indicated that almost all teachers had teacher-made manipulatives. Additionally, the principals reported that 54% of K-2 teachers used manipulatives for teaching math 60 minutes per week. However, non-manipulative instruction was reported to be predominant.

A further review of the literature indicated several possible reasons why teachers may not be using manipulatives during their mathematics instruction.

Anderson (1978) visited seventeen first grade classrooms in the Ohio area and observed only four classrooms that used manipulatives during math instruction. The author inquired why there was an absence of manipulatives and the responses included: children just want to play with them, they lose them, they cost too much, and they do not need them. The author also stated that resistance to the use of manipulatives stemed from pressures from administration to finish the textbook, to cut out the frills and to get back to the basics.

Smyth (1983) in an attempt to discover why American children have low mathematics scores visited 125 primary schools in

thirty-two countries. Smyth found many similarities and differences in the countries pertaining to class size, school starting age, instructional styles, and in types and uses of manipulative materials. From the author's observations she concluded that American schools need to allow children enough time to assimilate information, through repeated exploration and experimentation, as they develop their understandings of mathematical concepts. More experiences in counting, sorting, and ordering need to be provided for students through the use of manipulatives.

Herbert (1985) identified problems in using manipulatives as: not enough time is available to use manipulatives, their use is the same as playing games, and they are difficult to manage with a large group of students. Herbert advocated the use of manipulatives for three reasons: manipulatives motivate students, manipulatives stimulate students to think, and manipulatives informally introduce mathematical concepts. The author explained that the use of manipulatives results in improvements in motivation, involvement, and achievement, therefore, manipulatives are "good mathematics".

Worth (1986) briefly reviewed the evidence to the long recognized and widespread support for using mathematics manipulatives. Worth stated that even with the evidence manipulatives are not being used extensively. The author gave possible reasons for the lack of use which included: financial constraints on education, teacher's concerns about management and control, and the emphasis on technology and computers for learning mathematics.

Stone (1987) discussed the reason why teachers may not be using manipulatives for mathematics instruction. Reasons included: manipulatives are too expensive, the need for accountability, worksheets are more convenient and worksheets provide for a quiet, controlled and structured atmosphere. The

author presented several activities that enable young children to discover math concepts. These activities were of low cost, easily prepared, developmentally appropriate and were accompanied by follow-up activities that could be taken home. Stone stressed that concrete manipulative experiences are necessary as they provide understanding which helps in the transition to more graphic or abstract worksheet activities.

Scheer, Presley and Small (1984) acknowledged the importance of using mathematics manipulatives. Because of the expense involved in purchasing commercially-made manipulatives, the authors described nine teacher tested hands-on activities using kitchen shelf items. Cheerios cereal, beans, straws and string were among the items used in the suggested activities.

Turkel, Sicklick and Curcio (1988) briefly discussed the important role of manipulatives and acknowledged the fact that commercial manipulatives are often too expensive, therefore, many teachers do without manipulatives. In an effort to overcome the problem of expensive manipulatives the authors presented several activities which utilized ordinary buttons for teaching basic mathematical concepts.

VanDevender (1988) conducted a study to identify problems elementary teachers encountered while teaching mathematics. The results indicated that 90% of the teachers agreed that the need for more concrete materials and the need for different ability levels were problems. Fifty percent of the teachers agreed that textbook organization and lack of teacher input into the programs were also problems. Forty-four percent stated that there was not enough classroom time for mathematics instruction.

A review of the literature presented many techniques, ideas, and suggestions for assisting teachers to become more knowledgable in their use of manipulatives for mathematics instruction.

As a result of observations made in 17 first grade classrooms, Anderson (1978) conducted a program to prepare prospective teachers in the use of counting sticks for teaching basic mathematics concepts. Informal test results indicated that when prospective teachers who were trained in the use of manipulatives went into the classrooms, those children who were given an opportunity to develop number concepts using manipulatives showed significantly more progress and retention of concepts than those not exposed to the manipulatives.

As an instructor of mathematics methods courses at Louisiana State University, Young (1983) required perservice teachers to use manipulatives in their actual teaching situations. The author briefly described activities and techniques that were used to expose preservice teachers to the value of using manipulatives when teaching mathematical concepts to young children. Young stated that after perservice teachers became competent in using manipulatives they were sold on their use.

Trueblood (1986) discussed the preparation of prospective teachers to use manipulatives within the context of the elementary and early childhood education program at Pennsylvania State University. Prospective teachers were instructed in the selection and use of manipulatives that correctly represent the mathematical concepts instructed. Additionally, the prospective teachers were instructed in the planning and management of math instruction that involves the use of manipulatives. The author explained that teachers generally use manipulatives in their classrooms in the same manner in which they were taught to use them.

Johnson (1987) described an in-service approach which was intended to help teachers understand and appreciate the value of manipulative materials. The in-service program described by Johnson taught teachers metrics through the use of manipulatives. By the end of the in-service sessions teachers had a repertoire of hands-on activities that could be used in their own classrooms.

The author explained that this process has proven successful as teachers are convinced that what worked for them to learn will work for the students they teach.

Flener (1978) described a three year experimental project which was undertaken to give mathematical continunity to activities that made use of manipulative materials for K-2 grade students. The author described the techniques which used attribute blocks to teach mathematical functions. This project was not a research project and gains in academic achievement were not formally calculated. However, the project was effective in assisting in the development of mathematical concepts.

Mueller (1985) described a model that outlined a scope and sequence for choosing mathematical experiences appropriate for children about the age of five. The model emphasized the role of manipulatives and stressed that early childhood mathematics activities should be concrete, hands-on investigations. The model presented was intended to act as a springboard for generating classrooms which would possess a host of activities and materials that would be manipulated by the young learner.

Lewis (1985) described an approach similar to the language experience approach used in reading which would make the connection between manipulation and computation real to the students. The first step of this language learning process is the development of mathematical ideas. This step is termed the "concrete phase" and is based upon manipulative materials experienced by the senses. The second step is represented by words, symbols and pictures and is termed the "representational phase". The third step is termed the "abstract phase" and involves computations of numbers and algorithms which are generalized from previously learned concepts. The authors included an annotated bibliography which described many valuable resources.

Bright (1986) discussed the use of manipulatives for teaching mathematics. He stressed the fact that manipulatives can provide an oral language base while complementing the symbolic side of mathematics; however, the manipulatives must reflect the same concept as the mathematics symbol. Teachers, therefore, need to find adequate ways of incorporating manipulatives into their instruction and to help students make appropriate connections between manipulatives and symbols.

Heddens (1986) stressed the need for a careful sequencing of activities to assist students as they move from the concrete to the abstract level as he discussed the importance of providing a smooth transition. The author divided Piaget's concrete and abstract stages into two levels, the semiconcrete and semiabstract, and described how learners must internalize new knowledge through concrete activities as they move along a continuum before arriving at the abstract level. Heddens stressed that simply using manipulative materials in teaching math is not sufficient. Teachers must guide children as they develop thinking skills and move along the continuum.

Touger (1986) agreed that concrete materials and models are valuable in helping children develop an understanding of mathematical concepts. However, the author stressed that a model which works with one student may be a problem for another student. Touger offered several suggestions for teachers to use when using manipulative models in developing mathematical concepts so that the manipulative experience may bring about the most positive result.

McBride and Lamb (1986) emphasized the importance of using concrete materials to teach fractional concepts to young children. The authors stated that teachers often have the materials and resources for teaching such concepts, but they do not know how to utilize them. McBride and Lamb presented suggestions for making

inexpensive manipulative materials and they provided suggestions for using these materials.

Beattie (1986) stressed the importance of using manipulative objects in developing an understanding of algorithms. Four distinct reasons for using manipulatives were discussed. The reasons included: manipulatives clarify the concept or meaning of each operation, manipulatives clarify the language of each operation and algorithm, manipulatives clarify the algorithm, and manipulatives clarify pictorial representations.

Flexer (1986) presented a method of teaching basic addition and subtraction that facilitates learning by using concrete models of numbers. The goal for using this method and its models is mental manipulations of numbers. The models emphasized the base ten system and showed single digit numbers in terms of base five. The author explained that using these materials enabled the student to develop and retain images of numbers. This in turn allowed for and strengthened learning, retention, and application of addition and subtraction facts.

Bezuk (1988) described activities using manipulatives to introduce fractional concepts in the early childhood years. Bezuk stressed the importance of using manipulatives and that the use of manipulatives should not be abandoned prematurely. The author suggested that after introducing several manipulatives, students should be allowed to choose the manipulative they perfer to use. Students, therefore, have an opportunity to select the model that makes the idea most meaningful to them.

Additional literature provided assistance to educators in selecting manipulative materials appropriate for young children.

Reyes (1971) provided a rationale and guidelines for the selection and use of manipulative materials. He presented both pedagogical and physical criteria to consider in the selection of manipulatives. Reyes' pedagogical criteria included: materials

should serve the purpose for which they are intended, be mathematically appropriate, clearly represent the mathematical concept, be motivating, should provide a basis for abstraction, should provide for individual manipulation, and be multipurposeful. Physical criteria included: durability, attractiveness, simplicity, cost, size, and storage space. Reyes stressed that manipulatives must be used at the right time and in the right way if they are to be effective. Reyes gave many do's and don'ts for teachers who plan to use manipulatives.

Hynes (1986) discussed the process and criteria for the selection of manipulative materials. The process of selecting manipulatives is the first step in helping children understand math. Without appropriate materials, understanding of concepts is hampered. The author identified pedagogical criteria and physical criteria that need to be considered before selecting manipulative materials. The pedagogical criteria included: appropriateness for student's developmental level, interest, versatility, and clear representation of the math concept in question. The physical criteria included: simplicity, attractiveness, manageability and ease of storage, and reasonableness of cost.

Moser (1986) sited several questions concerning the use of manipulatives. Examples of the questions included: should manipulatives be used by all children, should manipulatives be integral to instruction or an adjunct, should manipulative based lessons be open-ended or structured, and what kinds of manipulatives should be used. The author also included explanations and solutions for the questions posed.

In conclusion, a review of the related literature presented evidence that manipulatives are important in assisting children in their development of mathematical concepts. The literature indicated that manipulatives are somewhat available in many classrooms; however, teachers did not appear to be using these materials to assist them in their instruction of

mathematics. The literature indicated that teachers did not use manipulatives in their instruction of mathematics concepts for various reasons. Several reasons noted were: lack of availability of needed manipulatives, the high costs of manipulatives, not enough time to use manipulatives, difficulty in managing the use of the manipulatives, the need for accountability, plus the fact that worksheets are more convenient. Additionally, the literature presented many suggestions for teachers to enable them to increase their usage of manipulatives for teaching mathematical concepts.

CHAPTER III

ANTICIPATED OUTCOMES AND EVALUATION INSTRUMENT

Statement of General Goals

The use of manipulatives for teaching mathematics in K-2 grade classrooms is very important for the student in developing basic mathematical concepts. Therefore, the goal for this practicum was to increase the availability and the usage of manipulatives in K-2 grades through effective staff development activities.

Behavioral Expectations

An analysis of the related literature which discussed the importance and value of using manipulatives in teaching mathematics revealed that manipulatives were not frequently being used in primary classrooms. The related literature provided suggestions for increasing the availability and usage through various staff development activities.

With this in mind, the following specific behavioral objectives were projected for this practicum.

1. Over a period of 12 weeks, K-2 grade teachers will increase their current supply of mathematics manipulatives by 50% as indicated by a postimplementation survey of available selected materials.

2. Over a period of 12 weeks, K-2 grade teachers will increase their use of manipulatives for teaching mathematical concepts by 50% as indicated by a postfrequency usage score.

3. Over a period of 12 weeks, K-2 grade students will increase their use of mathematics

manipulatives by 50% as indicated by a post implementation teacher observation checklist.

4. Over a period of 12 weeks the school site will increase the current supply of mathematics manipulative resource guides and reference sources available to teachers by 50% as indicated by a postimplementation inventory of mathematics resource/reference publications.

Evaluation Instrument

The first behavioral objective was to be measured using a postimplementation survey of availability and usage of selected materials (see Appendix B). This evaluation instrument was identical to the preimplementation survey used to assess the current availability of mathematics materials. The survey was familiar to the teachers, therefore, it allowed teachers to quickly determine the current availability of the selected materials. The survey included 36 items that the present school's adopted mathematics series suggested teachers use, plus additional materials the writer believed K-2 teachers should have for mathematics instruction. This evaluation instrument allowed for an easily computed analysis for any increases in availability of the materials.

The second objective also was to be measured using a post implementation survey of availability and usage of selected materials. This survey was identical to the preimplementation survey. Teachers were to be asked to check the appropriate column to indicate the frequency with which the selected items were used. Additionally, a frequency usage score was to be calculated to facilitate the analysis of the freguency of use for each of the 36 selected materials. This measurement was similar to the

measurement used by Scott (1983). Scott calculated a total material use figure for each response on his survey of selected materials in order to study the difference in materials used between grade levels.

The frequency usage score was to be determined by assigning a value to each of the frequency of use responses. The assigned response values were: "Very often" - 4 points, "Often" - 3 points, "At times" - 2 points, "Rarely" - 1 point, and "Never" - 0 points. If for example, the abacus had four responses "At times" and one response "Often", the resulting frequency usage score was 11 (4 x 2 + 3 = 11).

The percent of increase between the pre and postfrequency usage score was to be derived using the same procedure as described for finding the percent of increase between the pre and postsurvey of available selected materials for objective one.

The third objective was to be measured using a post implementation teacher observation checklist (see Appendix D). The checklist was designed by the writer and was approved for use by the K-2 teachers who participated in the practicum. The checklist indicated the specific manipulative usage by students, as observed by the teacher on a weekly basis. The checklists were to be collected weekly and a running total was to be kept for each of the five categories of usage. An average weekly usage score was computed for each category at the end of the practicum implementation period.

Increasing the students' use of mathematics manipulatives was to be analyzed by comparing the preimplementation results of the teacher questionnaire item #30 ("How many days per week do students use math manipulatives?") to the observed students' average weekly usage score from the teacher observation checklist. The percent of increase between the two scores was to be derived using the same procedure as described for objective one.

The fourth objective was measured by a postimplementation inventory of mathematics resource/reference publications (see Appendix C) available at the school site. This measure allowed for a quick analysis of the available school site mathematics resources. Increasing the current inventory of mathematics resources/reference publications was to be analyzed by comparing the results of the pre and postimplementation inventory of mathematics resource/reference publications. The percent of increase between the pre and postinventory results was to be derived using the same procedure as described for objective one.

Because of the extended time period for the completion of the implementation of the practicum, provisions were included to account for possible unexpected events. A weekly log (see Appendix E) was to be kept. The log was to include the writer's observations and comments, as well as comments and suggestions made by other teachers concerning the various staff development activities. The weekly log was to be useful to the writer as a means to determine which staff development activities were most successful. In addition to the weekly log, the writer was to keep a related staff development activities rating scale (see Appendix F) which teachers were to complete following the staff development activities. The rating scale was to be used to determine the effectiveness of the staff development activities.

CHAPTER IV

SOLUTION STRATEGY

Discussion and Evaluation of Solutions

The use of manipulative materials is very important for the development of mathematical concepts in young children. A review of the literature acknowledged this importance, yet presented evidence that mathematics manipulatives were not readily available or frequently used in the classroom. The increase of availability and usage of mathematics manipulatives were the aims of this practicum.

One solution to increase the availability of mathematics manipulatives was to have teachers, parents or children make these materials. The literature contained articles (Chapman, 1987; McBride and Lamb, 1986; Stone, 1987) which presented suggestions and directions for making mathematics manipulatives. Additional literature (Anderson, 1978; Stone, 1987; Turkel, Sicklick and Curcio, 1988; Worth, 1986) indicated that commercially-made manipulatives were expensive. Therefore, making mathematics manipulatives would benefit teachers who did not have available funding for the purchase of commercially-made materials. However, a criticism of teacher-made manipulatives was that these materials did not meet the physical criteria described in the literature (Hynes, 1986; Reyes, 1971) for selecting math manipulatives. Teacher-made manipulatives were not as durable or attractive as commercially-made manipulatives.

A second solution to increase the availability of mathematics manipulatives was to use common, everyday household items including food items. The literature presented articles (Scheer, Presley and Small, 1984; Stone, 1987; Turkel, Sicklick and Curcio, 1988) which gave suggestions for using inexpensive items. The benefit of using everyday household items was the same as

described for teacher-made materials. Using household items or food items, such as cheerios, beans or m & ms, enabled teachers who could not afford commercially-made manipulatives an opportunity to have some type of manipulative materials available for their students to use.

The drawbacks for using household items were similar to the drawbacks for teacher-made materials as these items did not meet the physical criteria for the selection of manipulatives. Using food items presented additional problems as children were tempted to eat the food items. These food items may have fallen on the floor, been placed on dirty desk tops, or handled by many other students. Therefore, these items were no longer safe to consume. If these items were eaten, how would children visualize the results?

In spite of the drawbacks regarding the use of teacher-made, student-made, parent-made or common household manipulatives and food items, these materials were very effective in teaching mathematical concepts to young children. In fact, having parents and children assist in making manipulatives added a motivational factor. Students became more active participants in activities which they were responsible for creating. Additionally, using objects which students were familiar with was another important factor to consider when teaching new concepts.

A solution to increase the frequency usage of mathematics manipulatives was to provide prospective teachers mathematics methodology courses that included instruction in the use of manipulatives. Several studies (Anderson, 1978; Trueblood, 1986; Young, 1983) described university programs that offered prospective teachers instruction in the use of various manipulatives and an opportunity to practice using manipulatives within a classroom setting. The studies indicated an increase in the frequency usage of mathematics manipulatives as teachers became more competent in using the manipulatives and as they

realized how manipulatives assisted in the development of mathematical concepts in young children.

University programs offering mathematics methodology courses that included instruction in the use of manipulatives were a major benefit for prospective teachers as it increased teachers' competencies in integrating the use of manipulatives into their mathematics instruction. However, a drawback to this solution was that teachers who graduated prior to the implementation of these methodology courses, and those graduating from institutions not offering these courses were not exposed to instruction in the use of manipulatives. This solution was not appropriate for the writer's work setting for those involved in the practicum were practicing teachers and had already completed their required methodology courses.

Another solution to increase the frequency usage of mathematics manipulatives was to offer in-service activities to teachers. Johnson (1987) presented a teacher in-service approach which utilized manipulatives in teaching teachers about metrics. The effectiveness of teacher in-service activities for increasing the usage of manipulatives for teaching mathematical concepts were also reported by Scott (1983) and Scott (1987).

Using an in-service approach was a benefit as teachers were able to participate in a program which was intended to provide new ideas and ways to improve and enhance classroom instruction. In-service activities provided an informative and relaxed atmosphere. After teachers experienced learning through the use of manipulatives, they better understood the value of using manipulatives as part of their instructional presentation. However, scheduling was a drawback for teachers wanting to attend these sessions. Many teachers were unable to arrange time after school and locations other than the teachers' own school site posed transportation problems. Problems with scheduling and transportation could be avoided by using the school site.

Another solution to increase the frequency usage was to provide teachers various resource/reference publications explaining how to integrate the use of manipulative materials for teaching specific mathematical concepts. Numerous articles (Bezuk, 1988; Flener, 1978; Flexer, 1986; Lewis, 1985; McBride and Lamb, 1986; Muller, 1985; Stone, 1987; Touger, 1986) have been written by educators for educators. These articles shared methodology and results which others in the field could replicate to improve and enhance their own instruction.

Articles written by one's peers were a great benefit. There exists a comradery among teachers as teachers appear are often receptive to each other's suggestions. Who better understands a teacher's problem than another teacher? Having resource/ reference publications, pertaining to the integration of manipulatives into the mathematics instruction, available to teachers was an effective way to increase the use of manipulatives. Through the availability of these publications, teachers had a greater opportunity to find out what their peers were doing to improve and enhance their classroom instruction.

Description of Selected Solutions

Solutions to the problem of increasing the availability and use of mathematics manipulatives in K-2 grade classrooms were based on the various approaches which have been described previously.

Several methods were employed to increase the availability of mathematics manipulatives in K-2 grade classrooms. One method was to obtain support from the administration. Many times administrators were not aware of the current research supporting the use of various instructional materials and classroom techniques used to improve or enhance instruction. Support from the administration is extremely necessary for the success of projects or activities initiated by teachers. Therefore, by

communicating to the administration the need and value of using mathematics manipulatives in K-2 grade classrooms and the current research supporting the use of manipulatives for teaching mathematical concepts, the writer secured the administration's support to purchase manipulative materials and to present staff development activities.

The Parent Teacher Association (PTA) at the writer's work setting is an active organization and very willing to assist the teachers in their efforts to improve instruction. Each year the PTA asks the teachers what they would like the PTA to do for the school. Therefore, as a second method to increase the availability of mathematics manipulatives, recommendations were made to the PTA to raise funds for the purchase of mathematics manipulatives in K-2 grade classrooms. The writer presented the need for children to use manipulative materials and acquired the PTA's support for purchasing mathematics manipulatives for K-2 grade classrooms.

Each year a public educational funding organization offers teachers an opportunity to apply for grant monies to improve the quality of instruction in their classroom. Therefore, a third method to increase the availability of mathematics manipulatives was to write a proposal for an educational grant. Writing a grant was an excellent method used to obtain monies to purchase manipulatives which would be of benefit to K-2 students for years to come.

A fourth method to increase the availability of mathematics manipulatives involved the writer assisting K-2 grade teachers in making their own manipulatives to use for the instruction of specific mathematical concepts. In spite of the drawbacks regarding teacher-made manipulatives, these materials were effective in teaching mathematical concepts.

To increase the frequency usage of mathematics manipulatives in K-2 grade classrooms by teachers, as well as by students, several methods were employed. The teacher questionnaire completed by K-2 teachers indicated that 10 out of 12 teachers would attend workshops and/or in-service activities pretaining to the use of manipulatives for teaching mathematics. Therefore, one method was to arrange for workshops and/or in-service activities pertaining to the use of mathematics manipulatives. Through the in-service activities teachers had an opportunity to share ideas and discuss methods and techniques that have worked for them. Useful suggestions and knowledge were gained by teachers as they had an opportunity to interact with one another.

Another method to increase the use of mathematics manipulatives required support from the administration and media specialist. The writer obtained their support to purchase resource/reference publications for teachers to use concerning mathematics instruction. Schools should provide teachers with access to a curriculum library. Educational journals such as Arithmetic Teacher; Mathematics Teachers; Creative Classrooms; Learning 88; and Instructor have many relevant articles which present activities that teachers can incorporate into their classroom instruction. Reference guides such as Numbers in Pre-School and Kindergarten: Educational Implication of Piaget's Theory (Kamii, 1982); The Block Book (Hirsch, 1984); Active Mathematics Teaching (Good, Grouws & Ebmeier, 1983); and Preparing Young Children for Math: A Book of Games (Zaslavsky, 1979) are excellent sources which provide teachers with many suggestions for using mathematics manipulatives.

In summary, the writer recognized that mathematics manipulatives were not readily available in K-2 grade classrooms and that these materials were not frequently used. Therefore, the writer concentrated on effective related staff development activities such as teacher workshops and/or in-service activities,

peer-teacher support activities, and administration awareness and support to increase the availability and use of mathematics manipulatives.

Report of Action Taken

The solution strategies were divided into phases with each phase having several components. A component of the first phase actually began when the writer administered the preimplementation Teacher Questionnaire and the Survey of Availability and Usage of Selected Materials to K-2 grade teachers and the Inventory of Mathematics Resource/Reference Publications to the media specialist. The purpose of the teacher questionnaire, the survey of selected materials, and the inventory of publications was to find out what manipulatives and math resources were available to K-2 teachers and how often these materials were used.

A second component of the first phase was accomplished during the first two weeks of the practicum implementation. This component involved an introductory explanation and discussion with administrators and K-2 teachers regarding the value and need to use mathematics manipulatives. This component allowed the teachers and administrators an opportunity to understand the purpose and aims of the writer's practicum.

The third component of this phase involved assisting the media specialist in writing a grant to secure monies for the purchase of educational journals and resource/reference guides pertaining to mathematics instruction. The media specialist's grant was not accepted, however, the media specialist obtained monies from matching fund accounts which enabled her to purchase the educational journals. Additionally, teachers voluntarily purchased several of the resource guides and placed them on loan in the school's curriculum library.

The final component of the first phase, was also completed during the first two weeks of the practicum implementation. It involved contacting various organizations and companies that offered workshops and/or in-service activities pertaining to the use of mathematics manipulatives and to arrange for sessions at the writer's work setting.

Two private organizations were contacted that offered such workshops. One company was unable to schedule an acceptable time and the second company requested a fee which the school was not able to afford. The writer contacted two additional educational groups which were presenting workshops within the county area. One workshop interfered with the already scheduled PTA carnival which the teachers were previously committed to and the second workshop conflicted with a scheduled teacher planning day designated for completing student report cards.

In a final attempt to schedule a workshop or in-service, the writer contacted the school site Teacher Education Center (TEC) representative. The writer inquired whether TEC offered a course which pertained to mathematics instruction using manipulatives. It was learned that there were no courses currently available through TEC.

The writer communicated the problems of arranging for workshops with the administration and K-2 teachers. At that time it was agreed that this writer would give "mini" workshops for the teachers. These workshops are discussed in phase three of the practicum implementation.

Upon completion of the first phase components, the second phase began. This phase occured during the third and fourth week and involved obtaining funds to purchase manipulative materials. The first component of the second phase involved contacting the Parent Teacher Association (PTA) to gain their support for raising funds to purchase mathematics manipulatives for K-2 grade

classrooms. A school carnival was organized by the PTA. The writer obtained permission from the administration and PTA to have a booth (a fish pond booth) at the carnival with all proceeds being applied to the purchase of math manipulatives. Several of the first grade teachers volunteered to assist in working at the booth. The carnival took place on a Saturday and was a huge success. The fish pond booth raised $185.00 for the purchase of math manipulatives.

A second component of phase two involved applying for an education grant to receive monies to purchase mathematics manipulatives for K-2 classrooms. The writer obtained and completed a grant application requesting $623.00. The grant was titled "Manipulatives: Motivating Mathematics". The grant was submitted during the third week of the practicum implementation. However, the writer was notified at the end of the twelve week practicum implementation period, that she was awarded the grant. The writer received $600.00. Grant monies will be used to purchase mathematics manipulatives. A "lending library" will be established to allow children to check out the manipulative materials for use at home. Additionally, workshops will be offered to assist parents in helping their children use the materials at home. These strategies parallel those stipulated in the grant.

The third phase involved utilization of effective staff development activities and was accomplished during the fifth through the twelfth week of the practicum implementation. During phase one of the practicum it was decided that this writer would give "mini" workshops pertaining to the use of math manipulatives. Four "mini" workshops were scheduled from 2:00 pm to 3:00 pm on Wednesday afternoons. This time did not conflict with K-2 teachers as it coincided with their scheduled planning time.

The first workshop presented current literature which addressed the importance of using math manipulatives. A group

discussion concerning the actual uses of manipulatives also took place. The second workshop presented the teachers with the new math manipulatives materials purchased with the proceeds from the PTA carnival. The writer gave a brief explanation for each of the items. A question and answer period followed. The third workshop was a "make and take" session. The writer presented several patterns for math manipulatives which the teachers copied for their classroom use. Patterns included: tangrams, geometric cut-outs and templates, and sorting kits. During the make and take session ideas were shared as to how these materials could be used with the students. The fourth workshop presented the uses of cuisenaire rods and unifix cubes. Several teachers were familiar with cuisenaire rods, however, none of the teachers who attended this session had used unifx cubes. Therefore, the workshop concentrated on the use of unifix cubes with similarities between cuisenaire rods and unifix cubes being discussed.

A final component of phase three involved assisting teachers in using manipulatives to teach specific mathematical concepts. The writer worked with teachers during their math instructional time to facilitate the teachers' uses of manipulatives. The writer presented actual manipulative lessons for other teachers' classes to give the teachers an opportunity to observe the use of manipulatives in a classroom setting.

The fourth and final phase of this practicum was the evaluation phase. This phase was accomplished following the twelfth week of implementation.

The first component involved the postimplementation of the survey of availability and usage of selected materials and involved calculating the percent of increase. The second component of the final phase involved calculating the postfrequency usage score for each of the selected materials and the percent of increase. The third component involved the postimplementation of the teacher observation checklist concerning

the use of mathematics manipulatives by their students. This component also involved calculating the average weekly student usage as observed by the teachers and finding the percent of increase. The fourth component involved the postimplementation of the inventory of mathematics resource/reference publications. The results of the practicum are discussed in the next chapter.

CHAPTER V

RESULTS CONCLUSIONS AND RECOMMENDATIONS

Results

The first objective, increasing the availability of selected materials, was analyzed by comparing the results of the pre and postimplementation survey of available selected materials. The percent of increase between the pre and postsurvey was derived by first finding the difference between the pre and postsurvey results. The difference was then divided by the presurvey results. To convert the quotient to a percent, the quotient was multiplied by 100. A further explanation of the analysis is described as follows:

	Teachers indicating availability	
Selected Material	Presurvey	Postsurvey
Beads	2	8

8 - 2 = 6 ------- Difference between pre and post results
6 / 2 = 3 ------- Divide difference by the presurvey
3 x 100 = 300 ------- Multiply the quotient by 100
300% ------- Percent of increase from pre to post

The results and the percent of increase for each of the selected materials are shown on Table 5. The findings indicated that 12 of the 36 selected materials resulted in increases of 50% or more. Those items included: cuisenaire rods, dominoes, fraction sets, geoboards, geometric forms, measuring cups, money kits, parquetry kits, place value carts, sorting kits, tangrams, and unifix cubes. Five of the 36 selected materials resulted in increases between 9% and 40%. Those items included: abacus, clocks, counters, flash cards, and number lines. There were 19 items out of the 36 that did not show any increase.

Table 5

Availability of Selected Materials Increases

Selected Materials	Pre Survey	Post Survey	% Of Increase
Abacus	5	7	40
Attribute blocks	2	2	0
Beads	7	7	0
Bottle tops	1	1	0
Calculators	3	3	0
Calendar	12	12	0
Chip trading	2	2	0
Clocks	11	12	9.09
Containers (qt,pt)	3	3	0
Counters	9	12	33.3
Counting frame	1	1	0
Cuisenaire rods	3	6	100
Dominoes	5	8	60
Flash cards	9	11	33.3
Fraction sets	2	7	250
Geoboards	1	9	800
Geometric forms	2	9	350
Measuring cups	1	1	133
Measuring spoons	1	1	0
Money kits	6	12	100
Number lines	6	7	16.6
Number rods	1	1	0
Parquetry kits	1	2	100
Peg boards & pegs	2	2	0
Place value chart	2	3	50
Popsicle sticks	7	7	0
Puzzles	7	7	0
Rulers, metric	6	6	0
Scales	1	1	0
Sorting kits	2	8	175
Tangrams	1	11	1000
Thermometers	2	2	0
Timers	1	1	0
Telephone	1	1	0
Unifix cubes	0	4	400
Yardstick	8	8	0

The items which indicated increases of 50% or more were items that the teachers were introduced to during the mini workshop sessions. For example, during one session teachers made geometric patterns, tangrams, and sorting kits. This resulted in teachers indicating an increase in availability of these items. The items which resulted in increases of less than 50% were items that teachers indicated on the presurvey were already available to them. For example, the postsurvey indicated a 9% increase in the available of clocks. The presurvey, however, indicated that 11 of the 12 teachers already had clocks available for their use. Therefore, an increase of 50% or more would not result as only one of the teachers needed clocks. Additionally, several of the items which showed no increase were not considered as mathematics manipulatives by the K-2 teachers. Puzzles, timers, telephones, scales, thermometers, and calculators were items not considered as manipulative items for students to use. Also, bottle tops and popsicle sticks resulted in no increases as teachers stated that they had other items that served as counters.

There were several math manipulative items ordered by K-2 teachers which were not included on the original survey of selected materials. These items were ordered and are now available for teachers to use. This increase occurred as a result of the mini workshops where teachers had an opportunity to look through current educational catalogs which presented many new math manipulative. Items now available, which were not on the survey, included, math balances, math folder games, primary math game bags, arithmetic tubes, math can do 6 paks, learning links, base ten tile kits, computers and mathematics computer software..

The second objective, increasing the frequency usage of selected materials, was analyzed by comparing the results of the pre and postfrequency usage scores. The results of the pre and postfrequency usage scores and the percent of increase for each item is shown on Table 6.

Table 6

Frequency Usage Scores Increases

Selected Materials	Pre Survey	Post Survey	% Of Increase
Abacus	11	16	45.45
Attribute blocks	4	5	25
Beads	16	19	18.75
Bottle tops	3	3	0
Calculators	8	8	0
Calendar	44	46	4.5
Chip trading	3	3	0
Clocks	30	36	20
Containers (qt,pt)	6	10	66.67
Counters	26	41	57.69
Counting frame	2	3	50
Cuisenaire rods	7	15	114.28
Dominoes	8	18	125
Flash cards	31	40	29
Fraction sets	6	18	200
Geoboards	4	27	575
Geometric forms	4	26	550
Measuring cups	7	14	100
Measuring spoons	3	4	33.33
Money kits	12	31	158.33
Number lines	18	23	27.78
Number rods	2	2	0
Parquetry kits	4	7	75
Peg boards & pegs	3	9	200
Place value chart	5	8	60
Popsicle sticks	18	18	0
Puzzles	23	23	0
Rulers, metric	13	13	0
Scales	2	2	0
Sorting kits	8	30	275
Tangrams	2	32	1500
Thermometers	4	4	0
Timers	1	1	0
Telephone	4	4	0
Unifix cubes	0	12	1200
Yardstick	14	14	0

The results indicated that 16 of the 36 items had usage increases of 50% or more. These items included: containers (qt. and pt.), counters, counting frames, cuisenaire rods, dominoes, fraction sets, geoboards, geometric forms, measuring cups, money kits, parquetry kits, peg boards and pegs, place value charts, sorting kits, tangrams, and unifix cubes. Eight of the 36 selected materials resulted in increases between 4% and 46%. These items included: abacus, attribute blocks, beads, calendars, clocks, flash cards, measuring spoons, and number lines. There were 12 items which did not result in any increase.

The items which resulted in increases of 50% or more were items that the teachers again were introduced to during the mini workshop sessions. The teachers had an opportunity to make several of the items such as geometric forms, tangrams, and sorting kits and they were given suggestions for using these items. The teachers, therefore, felt competent in using these materials which resulted in increases in the frequency usage scores of these items. Items such as scales, timers, telephones, thermometers, and calculators showed no increases in usage for similar reasons as previously discussed as teachers did not consider these items as manipulatives to use for instruction of basic mathematics skills.

The frequency usage scores were also dependent on the particular skills being instructed during the practicum implementation. For example, the first units of instruction in kindergarten and first grade involved basic geometric shapes and number recognition. The high rate of usage increases of these manipulative items corresponded to teachers' instructional time frame. Units such as money, time, and measurement are instructed at the end of the school year, therefore, little or no increase of usage were reported for these manipulative items during the practicum implementation time frame.

The results of the third objective, increasing students' use of mathematics manipulatives, are found on Table 7 and Table 8. The results of the postimplemented teacher observation checklist (Table 7) indicated that students were using manipulatives in all areas of math instruction, for the introduction of new concepts, for the reinforcement of concepts, during independent math activities, during group math activities, and during student's free choice activities. The results indicated, for example, that an average of four teachers observed their students using manipulatives 3 days a week for the reinforcement of math concepts. The final column of the table indicated the average number of teachers who observed students using math manipulatives for all the methods described. This average was used in Table 8 to indicate the percent of change in the teachers' observed students weekly usage of math manipulatives.

Table 7

Teacher Observation Checklist Results

	Student Usages					
Days Used	Intro.	Reinf.	Indep.	Group	Free	Avg. usage
0	0	0	0	0	0	0
1	5	3	0	2	0	2
2	5	3	3	3	1	3
3	2	4	2	3	4	3
4	0	2	5	2	5	2.8
5	0	0	2	2	2	1.2

The results of the teacher observed students usage was dependent on the unit being instructed and the instructional strategies used. Teachers generally introduce a new concept only 1 or 2 days per week. The remainder of the week is used for reinforcement and practice. This fact would result in lower

observed student usage of math materals 4 to 5 days per week for the introduction of new concepts. Independent use of math manipulatives would show increases in student usage as student became familiar with the concepts and materials. The results indicated that teachers observed students using math manipulatives during scheduled free time between 3 and 5 days per week. This result supports the belief that manipulatives greatly appeal to the senses of the young child and can and do motivate them to discover new concepts.

Table 8 shows the preimplementation results of the teacher questionnaire item #30 (How many days per week do students use math manipulatives?), the postimplementation teachers' observation checklist averages of student weekly usage, and the percent of increase or decrease between the pre and post weekly usage results.

Table 8

Students' Weekly Usage Results

Days	Pre	Post	% of Change
0	2	0	-100
1	4	2	- 50
2	1	3	200
3	2	3	50
4	3	3	0
5	0	1	100

A decrease in the use of math mathematics 0-1 day per week resulted in usage increases for 2, 3, and 5 days per week. The students' use of math manipulatives 2 days per week resulted in the greatest increase, 200%. An increase of 50% was shown for student using math manipulatives 3 days a week. There was no increase shown for students using math manipulatives 4 days a

week. However, the use of math manipulatives 5 days per week resulted in an increase of 100%.

The decrease of 100% for students using mathematics manipulatives 0 days a week and a decrease of 50% for 1 day per week was significant. The results indicated that as teachers became competent in using manipulatives and as the materials became available student usage increased. Students were exposed to these materials and encouraged to use them regularly.

The fourth objective, increasing the current inventory of mathematics resources/reference publications, was analyzed by comparing the pre and postimplementation of the inventory. The results shown on Table 9 indicated an increase in both the educational journals and in the resource books available to the teachers. Only 1 resource was available on the preinventory while the postinventory indicated that teachers now had 9 resources available. This resulted in an increase of 800% for objective four.

Although, the grant proposed by the media specialist was not accepted, the increase of materials occured as the media specialist secured matching funds to purchase several of the publications. Additionally, as a result of the mini workshops, the teachers elected to purchase several of these resources for the school. Additional resources were also purchased which were not on the original inventory. These items included: microcomputer software for addition drill, subtraction drill, and primary problem solving, mathematics filmstrips for problem solving, and math videos for basic addition, subtraction and telling time.

Table 9

Inventory of Mathematics Resource/Reference Publications

Postimplementation Results

Publications	Pre	Post
Arithmetic Teacher		
Creative Classroom		X
Elementary School Journal		
Instructor	X	X
Learning 88		
Mathematics Teacher		
Active Mathematics Teaching		
Hands-on Attribute Block Series		
Hands-on Geoboard Series		X
Hands-on Multilink Cubes Series		
Hands-on Tangrams Series		
Hands-on Unifix Cubes Series		X
Idea Book for Cuisenaire Rods (Primary)		X
Mathematics is More Than Counting		X
Number in Preschool and Kindergarten		X
One, Two, Buckle My Shoe		
Preparing Young Children for Math		
The Block Book		X
Workjobs I		X
Workjobs II		X

In an attempt to examine the positive and/or negative aspects of the practicum, teachers were asked to complete a staff development activities rating scale. The results indicated that workshop activities, facilitator assistance, and fund raising activities were rated as very successful. Teachers commented positively regarding the four mini workshops. There was much

sharing and exchanging of ideas during these sessions. Teachers rated the fund raising activities successful and commented that they would be willing to participate in another school carnival. The grant approval was met with great success and teachers commented that they could not wait to get six hundred more dollars worth of math materials.

The success of the resource/reference publications was rated as acceptable by the teachers. This was partially due to the media secialist's grant being denied. The writer believes that the teachers would benefit from the publications that were purchased, however, the general feeling of disappointment in being denied monies to purchase needed materials was expressed on the rating scale.

In conclusion, increasing the availability and usage of mathematics manipulatives through effective staff development activities was deemed to be a success. This was indicated by increases in available math manipulative materials, increases in the frequency with which teachers used math manipulatives for instruction, increases in student uses of math manipulatives and increases in available resources for teachers concerning the use of math manipulatives.

Conclusion

The first objective concerned itself with increasing the availability of math manipulative materials. This objective was met within the established criteria for several of the selected items as evidenced by the data presented in the previous section. Increases in availability occured as a result of fund raising acitvities, grant requests, and teachers making the math manipulatives. Increasing availability as a result of teachers making the materials supported the contentions of Scheer, Presley and Small (1984). They acknowledged that manipulatives are often expensive, and offered suggestions for making, teacher made

materials. Turkel, Sicklick and Curcio (1988) also believed that commerically made manipulatives were expensive and provided support for teacher created materials. Additionally, Stone (1987) presented several activities that could easily be made by teachers with follow up home activites. The success the writer had in increasing the availability of math manipulatives certainly verified the work of these authors.

The second and third objectives of this practicum involved increasing the teachers' and students' use of math manipulatives. Both objectives were met within the established criteria as again evidenced by the data presented in the previous section. Increases in teacher and student usage occured as a result of increasing the availability of materials and by teachers attending effective related in-service activities.

The success the writer had in increasing teachers' and students' usage of math manipulatives verified the work of several authors. Anderson (1978) indicated that teachers who were trained in the use of manipulatives would in turn allow their students an opportunity to use manipulatives. Young (1983) stated that after attending in-service activities teachers became competent in using manipulative and used them regularly in their classrooms. Trueblood (1986) and Johnson (1987) described in-service approaches and were convinced that teachers used manipulatives in their classroom in the same manner in which they were taught to use them.

The mini workshops conducted by the writer enabled teachers to become more familiar and competent in the use of a variety of math manipulatives. Through the teachers' increased awareness and competence, students in turn were able to increase their use of math manipulatives.

The fourth objective concerned itself with increasing resources/reference publications pertaining to mathematics

instruction. This objective, too, was met well within the established criteria and it verified the work of others. Bezuk (1988), Flener (1978), Flexer (1986), Lewis (1985), McBride and Lamb (1986), and Stone (1987) are just a few of the educators who have written articles sharing their methodologies and results for others. These resource/reference materials assisted teachers in similar ways in which in-service activities did. It is through these resource materials that teachers were able to discover what their peers were doing, and the methods and strategies which worked for them.

The evaluation of the various staff development activites further indicated the success of increasing the availability and usage of mathematics manipulatives through effective staff development activities. Teachers rated the workshops, funding activities, and writer assisted activities all as being successful.

In conclusion, this practicum proved that through effective related staff development activites, teachers were able to increase the availability of mathematics manipulative materials and teachers and students were able to increase their use of these math materials. Consequently, the writer intends to continue to offer mini workshops to teachers regarding new ideas and strategies for using mathematics manipulatives.

This writer believes that it was through the increased participation in the use of math manipulatives, that the K-2 grade teachers exhibited a renewed excitment for teaching math. This excitment was sensed by the students and as the teachers became more relaxed and confident in using the various math manipulatives, students' motivation and interest in mathematics increased.

Students and teachers were observed spending more time in the development of mathematical concepts. Students appeared very

excited and eager for math class to begin so they could use the tangrams, geoboards, and cuisenaire rods. Teachers reported that their students did not appear tense or frustrated during math instruction when they were allowed to use the various manipulative materials.

The mathematics manipulatives now available to the students as a result of this practicum, presented the opportunity for students to use their sensory abilities and to become more active participants in their acquisition of math concepts. Futhermore, students were facinated by the novelty of the manipulative materials.

This writer believes that children deal best with math concepts when allowed to first experience the concepts through activities involving the senses. The use of developmentally appropriate manipulative materials appeals to the students' senses and therefore will result in increases in curiosity and motivation for learning and experiencing new concepts.

Recommendations

The writer has four specific recommendations based on the results of this practicum. First, teachers should introduce new math concepts through the use of manipulatives whenever possible. Second teachers should allow students to use math manipulatives in a varitety of ways, for reinforcement and practice, during independent and group activities, and during student "free' time. Third, the administration should allow teachers reasonable yet necessary funds to purchase math manipulatives each year as these materials become worn through continual use. Finally, the teacher should be enthusiastic about the use of math manipulatives. This enthusiasm is easily sensed by young children and will add to the motivational factor for using math manipulatives.

It is the writer's belief that teachers should do everything possible to further their students' knowledge and desires to learn mathematics. Using math manipulatives will indeed add to the students' desires as math manipulatives are great motivators which make mathematics meaningful.

Dissemination

The results of this practicum were shared in several ways. The first way was the reporting of the practicum results to the K-2 teachers involved in the practicum. Secondly, the writer presented the practicum results to the administration. The admistration requested that these results be shared with the other staff members. Therefore, the results were presented to the third, fourth, and fifth grade teachers at the writer's work site.

The writer intends to share the results with the members of the Parent Teachers Association who supported the writer in securing funds during the carnival for the purchase of math manipulatives. Finally the writer would like to submit a copy of this practicum report to the local chapter of mathematics teachers.

REFERENCES

Anderson, A. (1978). Why the continuing resistance to the use of counting sticks? Arithmetic Teacher, 25, 18.

Beattie, I. D. (1986). Modeling operations and algorithms. Arithmetic Teacher, 33, 23-28.

Bezuk, N. S. (1988). Fractions in the early childhood mathematics curriculum. Arithmetic Teacher, 35, 56-60.

Bright, G. W. (1986). One point of view: using manipulatives. Arithmetic Teacher, 33, 4.

Charlesworth, R. (1984). Kindergarten mathematics: step-by-step from concrete materials to paper and pencil. Paper presented at the Annual Conference of the Education of Young Children (pps. 1-11). Los Angeles, CA.

Creswell, J. L., Gifford, C., & Huffman, D. (1988). Implications of right/left brain research for mathematics education. School Science and Mathematics, 88(2), 118-131.

Flener, F. O. (1978). If this is mathematics, why are the children climbing on the tables? Elementary School Journal, 78, 174-179.

Flexer, R. J. (1986). The power of five: The step before the power of ten. Artithmetic Teacher, 34, 5-9.

Heddens, J. W. (1986). Bridging the gap between the concrete and the abstract. Arithmetic Teacher, 33, 14-17.

Herbert, E. (1985). One point of view: manipulatives are good mathematics! Arithmetic Teacher, 32, 4.

Hynes, M. C. (1986). Selection criteria. Arithmetic Teacher, 33, 11-13.

Johnson, G. L. (1987). Using a metric unit to help preservice teacher appreciate the value of manipulative materials. Arithmetic Teacher, 35, 14-20.

Kennedy, L. M. (1986). A rationale. Arithmetic Teacher, 33, 6-7.

Kloosterman, P., & Harty, H. (1984). Current teaching practices in science and mathematics in Indiana elementary schools. Final report (Research Tech. Rep. No. 143). Bloomington, IN: Indiana University, School of Education. (ERIC Document Reproduction Service No. ED 285 772)

Kutz, R. (1977). An analysis of the use of math manipulative materials in North Dakota: No 8.. Grand Forks, ND: Bureau of Educational Research and Services. (ERIC Document Rep. Service No.ED 146 052)

Lewis, K. L. (1985). From manipulatives to computation - making the mathematical connection. Childhood Education, 61, 371-374.

McBride, J. W. & Lamb, C. E. (1986). Using concrete materials to teach basic fraction concepts. School Science and Mathematics, 86(6), 480-488.

Moser, J. M. (1986). Curricular issues. Arithmetic Teachers, 33, 8-10; 32.

Mueller, D. W. (1985). Building a scope and sequence for early childhood mathematics. Arithmetic Teachers, 33, 8-11.

Perry, L. M., & Grossnickle, F. E. (1987). Using selected manipulative materials in teaching mathematics in the primary grades (Research Tech. Rep. No. 143). CA: Southern California School District. (ERIC Document Reproduction Service No. ED 280 684)

Reyes, R. E. (1971). Considerations for teachers using manipulative materials. Arithmetic Teacher, 18, 551-558.

Scheer, J. K., Presley, C. A., & Small, M. C. (1984). Getting manipulative about math. Instructor, 94, 58-60.

Scott, P. B. (1983). A survey of perceived use of mathematics materials by elementary teachers in a large urban school district. School Science and Mathematics, 83(1), 61-68.

Scott, P. B. (1987). Perceived use of mathematics materials. School Science and Mathematics, 87(1), 21-24.

Smith, S. R., Szabo, M., & Trueblood, C. R. (1980). Modes of instruction for teaching linear measurement skills. Journal of Educational Research, 73, 151-153.

Smyth, M. (1983). Mathematics around the world. Arithmetic Teacher, 30, 18-20.

Sowell, E. J. (1987). Developmental versus practice lessons in the primary grades. Arithmetic Teacher, 34, 6-8.

Stone, J. I. (1987). Early childhood math: make it manipulative. Young Children, 42, 16-29.

Tobin, K., & Fraser, B. J. (1988). Investigations of exemplary practice in science and mathematics teaching in Western Australia. Journal of Curriculum Studies, 20, 369-371.

Touger, H. E. (1986). Models: help or hindrance? Arithmetic Teacher, 33, 36-37.

Trueblood, C. R. (1986). Hands on: help for teachers. Arithmetic Teacher, 33, 48-51.

Turkel, S. B., Scklick, F. P., & Curcio, F. R. (1988). Object lessons. Learning 88, 17, 74-76.

VanDevender, E. M., & Rice, D. R. (1984). The effect of three types of brain-based instruction on the mathematics achievement and attitudes of second grade student (Research Tech. Rep. No. 143). AL:Alabama Department of Education. (ERIC Document Reproduction Service No. ED 250 155)

VanDevender, E. M. (1988). Problems in teaching mathematics in elementary classroom. School Science and Mathematics, 88 (4), 308-314.

Wiebe, J. (1981). The use of manipulative materials in first grade mathematics: a preliminary investigation. School Science and Mathematics, 81, 388-390.

Williams, C. K., & Kamii, C. (1986). How do children learn by handling objects? Young Children, 42, 23-26.

Worth, J. (1986). By way of introduction. Arithmetic Teacher, 33, 2-3.

Young, S. L. (1983). How teacher educators can use manipulative materials with preservice teachers. Arithmetic Teacher, 31, 12-13.

APPENDIX A

TEACHER QUESTIONNAIRE

Please indicate your choice by checking the column that best describes your opinion of that question.

5 - Strongly agree
4 - Agree
3 - Somewhat agree
2 - Disagree
1 - Strongly disagree

	5	4	3	2	1
1. Math is one of my favorite subjects to teach.					
2. I am satified with the present math text.					
3. The math textbook is my main teaching aid.					
4. Adequate math manipulative materials are supplied in each student's workbook.					
5. The teacher's edition gives adequate suggestions for using manipulatives for teaching a lesson.					
6. My present knowledge of the use of math manipulatives is adequate.					
7. I feel comfortable about using manipulatives to teach math concepts.					
8. I understand the value of using manipulatives for teaching math concepts.					
9. I use resource/reference publications for ideas and ways for using manipulatives to teach math.					
10. I use math manipulatives when teaching new concepts.					
11. I use math manipulatives only when reinforcing concepts.					
12. My students use manipulatives when completing their assignments.					
13. My students do not need to use manipulatives when completing their assignments.					
14. Manipulatives act only as a crutch and can do more harm than good.					
15. There is not enough time to use manipulatives for teaching math concepts.					
16. Math manipulatives are usually too expensive.					
17. I have an adequate supply of math manipulatives.					
18. I do not need additional math manipulatives.					

	5	4	3	2	1
19. I believe the use of math manipulatives can assist in building a strong basic foundation.					
20. Fast learners do not need to use math manipulatives.					
21. Average learners benefit from the use of math manipulatives.					
22. Slow learners benefit the most from the use of math manipulatives.					
23. Math manipulatives are not needed above kindergarten and first grades.					
24. The use of math manipulatives is troublesome as students only play with the materials.					
25. I would like to have more math manipulatives for use in my classroom.					
26. I have attended workshops on using math manipulatives.					
27. I would be interested in attending future workshops concerning the use of math manipulatives in the classroom.					

28. How much time do you devote to teaching math each week?

_____ 0-2 hours _____ 4-6 hours

_____ 2-4 hours _____ 6 or more hours

29. How many days per week do you use math manipulatives when teaching math?

_____ 0 days _____ 2 days _____ 4 days

_____ 1 day _____ 3 days _____ 5 days

30. How many days per week do students use math manipulatives?

_____ 0 days _____ 2 days _____ 4 days

_____ 1 day _____ 3 days _____ 5 days

APPENDIX B

SURVEY OF AVAILABILITY AND USAGE OF SELECTED MATERIALS

Grade _____School_____Years of Experience_____

The following is a list of teaching aids sometimes used in elementary schools. Please check the aids you have in your classroom and the frequency with which you use them.

Very often - more than 10 times a year
Often - 5-6 times a year
At times - 3-4 times a year
Rarely - 1-2 times a year
Never - 0 times a year

	Availability	Usage				
Teaching aid	Have	Very often	Often	At times	Rarely	Never
Abacus						
Attribute blocks						
Beads						
Bottle tops						
Calculators						
Calendar						
Chip trading						
Clocks						
Containers (qt,pt)						
Counters						
Counting frame						
Cuisenaire rods						
Dominoes						
Flash cards						
Fraction sets						
Geoboards						
Geometic forms						
Measuring cups						
Measuring spoons						
Money kits						
Number lines						
Number rods						
Parquetry kits						
Peg boards & pegs						
Place value chart						
Popsicle sticks						
Puzzles						
Rulers, metric						
Scales						
Sorting kits						
Tangrams						
Thermometers						
Timers						
Telephone						
Unifix cubes						
Yardstick						
Other						

Would you like to have more of the above teaching aids?_____

Would you like to have an in-service on the use of aids?_____

INVENTORY OF MATHEMATICS RESOURCE/REFERENCE PUBLICATIONS

Please indicate which of the following suggested mathematics resource/reference publications are currently available in the school's curriculum library.

Educational Journals

- [ ] Arithmetic Teacher
- [ ] Creative Teacher
- [ ] Elementary School Journal
- [ ] Instructor
- [ ] Learning 88
- [ ] Mathematics Teacher

Resource Books

- [ ] Active Mathematics Teaching
- [ ] Hands-on Attribute Block Series
- [ ] Hands-on Geoboard Series
- [ ] Hands-on Multilink Cubes Series
- [ ] Hands-on Tangrams Series
- [ ] Hands-on Unifix Cubes Series
- [ ] Idea Book for Cuisenaire Rods (Primary)
- [ ] Mathematics is More Than Counting
- [ ] Number in Preschool and Kindergarten
- [ ] One, Two, Buckle My Shoe: Math Activities for Young Children
- [ ] Preparing Young Children for Math: A Book of Games
- [ ] The Block Book
- [ ] Workjobs I
- [ ] Workjobs II

APPENDIX D

TEACHER OBSERVATION CHECKLIST

STUDENT USAGE OF MATHEMATICS MANIPULATIVES

Please indicate your observation of your students usage of mathematics manipulatives each week by placing a check in the appropriate column(s). Thank you.

Student usage activities	Days per week 1	2	3	4	5
Usage during presentation of new mathematical concepts.					
Usage during reinforcement of previously instructed concepts.					
Usage during independent activities.					
Usage during group activities.					
Usage during "free time".					

APPENDIX E

WEEKLY LOG

DATE _____

STAFF DEVELOPMENT ACTIVITY _____

WRITER'S OBSERVATIONS/SUGGESTIONS:

K-2 TEACHER'S OBSERVATIONS/SUGGESTIONS:

ADMINISTRATION'S OBSERVATIONS/SUGGESTIONS:

APPENDIX F

STAFF DEVELPOMENT ACTIVITIES RATING SCALE

Please rate each of the following staff development activities using the following scale:

5 - Very successful
4 - Successful
3 - Acceptable
2 - Unsuccessful
1 - Very unsuccessful

WORKSHOPS AND/OR INSERVICE ACTIVITIES

|_____| Mini Workshop 1: Related Literature
|_____| Mini Workshop 2: PTA Purchased Materials
|_____| Mini Workshop 3: Make and Take
|_____| Mini Workshop 4: Cuisenaire and Unifix

WRITER ASSISTANCE ACTIVITIES

|_____| Presentation of classroom lesson
|_____| Making manipulatives
|_____| Facilitator/assistance

RESOURCE/REFERENCE PUBLICATIONS

|_____| Arithmetic Teacher
|_____| Mathematics Teacher
|_____| Creative Classroom
|_____| Learning 88
|_____| Instructor
|_____| Other...

FUNDING ACTIVITIES

|_____| Educational Grants
|_____| Parent Teacher Association
|_____| Administration Support